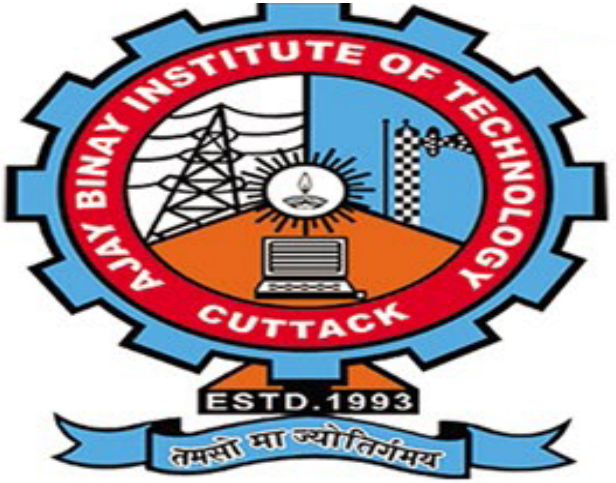

BASIC MANUFACTURING PROCESSES

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Module-II
WELDING PROCESS

Fabrication is often known as secondary manufacturing process as the method relies on the raw material obtained from the manufacturing process like extrusion and rolling. Fabrication is a process of joining two or more elements to make a single part. Most common examples are aircraft, ship bodies, bridges, building trusses, welded machine frames, sheet metal parts, etc.

Fabrication process can be classified as follows.

- Mechanical joining
- Adhesive bonding
- Welding, brazing and soldering

A particular fabrication method depends on number of factors

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•Type of assembly

Permanent, semi permanent or temporary

Joining those obtained by bolts or screws and can be disassembled whenever necessary are temporary in nature.

Rivets are semi-permanents fastening devices that involve making holes in the mating parts. Here joints can be separated by destroying the rivet without harming the parent elements.

•Materials being joined

Steel, cast irons, aluminium, similar or dissimilar metals

•Type of service required

Assembly subjected to heavy loading, impact loading, high temperatures

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Principle of welding

The welding process is a complex process that involves heat and liquid-metal transfer, chemical reactions. A gradual formation of the welded joint is obtained through liquid-metal deposition and subsequently there is a transformation from cooling into the solid state.

GAS WELDING

Gas welding is also named as oxy-fuel gas welding (OFW).Gas welding derives heat from the combustion of fuel gas such as acetylene in combination with oxygen. The process is a fusion welding process where the joint is completely melted to obtain the fusion.

Necessary considerations for gas welding Fuel Gases

Fuel gas for Gas welding used is acetylene due to its high temperature in the flame. Thereby the gas welding may be known as oxy-acetylene welding (OAW). Gas welding is a type of liquid state welding process in which fuel gases burns to generate heat. This heat is further used to melt interface surfaces of welding plates which are held together to form a joint. In this process,

Presentation on MPS Process
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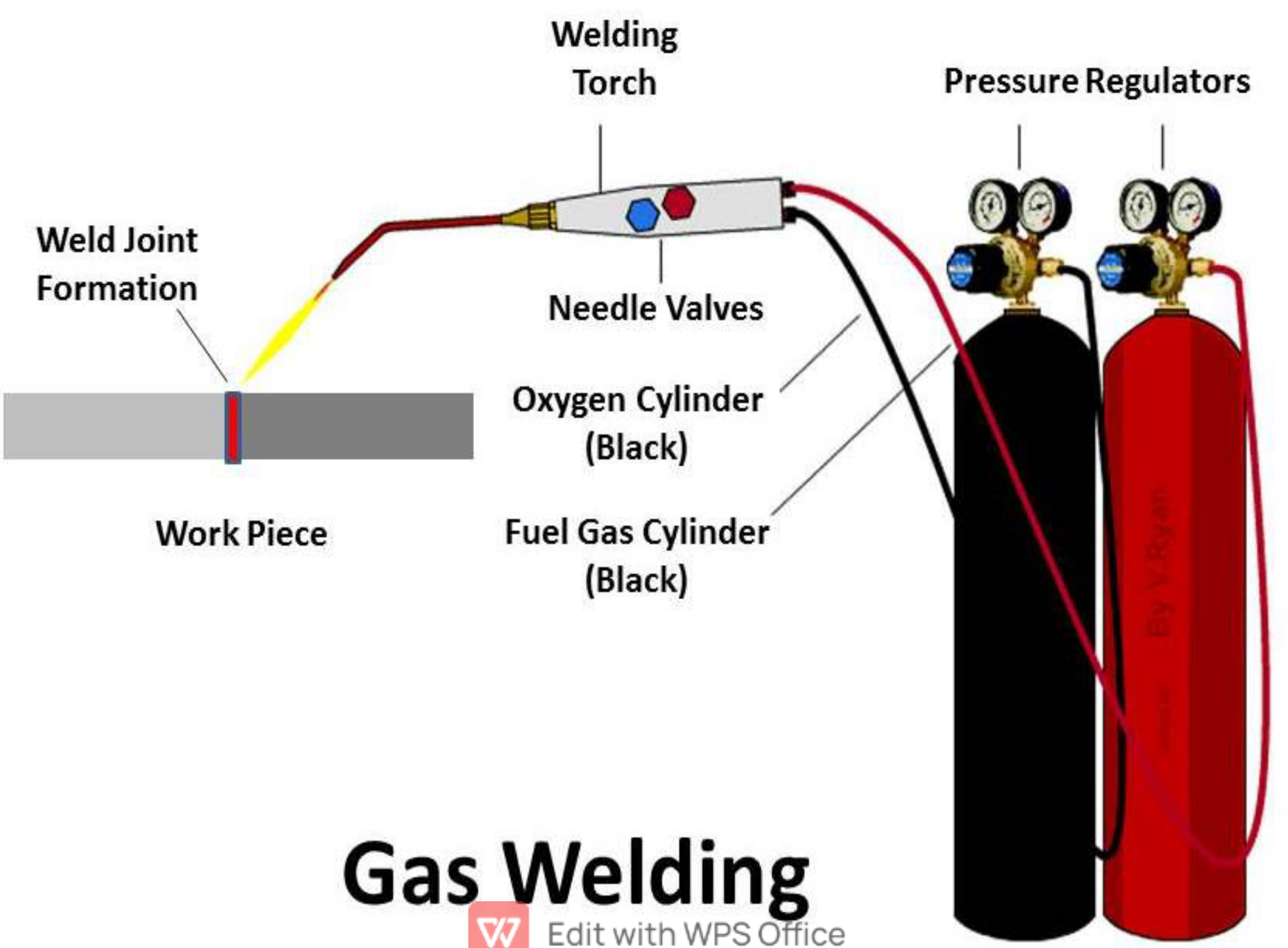
Gas welding is a type of liquid state welding process in which fuel gases burns to generate heat. This heat is further used to melt interface surfaces of welding plates which are held together to form a joint. In this process, mostly oxy-acetylene gas is used as fuel gas. This process can be done with or without help of filler material. If the filler material is used, it is fed directly into the weld area manually.



Gas Welding

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Equipment

Welding Torch:

Welding torches are most important part of gas welding. Both the fuel gas and oxygen at suitable pressure fed through hoses to the welding torch. There are valves for each gas witch control the flow of gases inside the torch. Both gases mixed there and form a flammable mixture. These gases ignite to burn at the nozzle. The fire flame flow through nozzle and strikes at welding plates. The nozzle thickness depends on the size of the welding plates and material to be welded.

A great variety of interchangeable welding tips differing in size, shape and construction are available commercially. The tip sizes are identified by the diameter of the opening. The diameter of the tip opening used for welding depends upon the type of metal to be welded.

Hose pipes

The hose pipes are used for the supply of gases from the pressure regulators. The most common method of hose pipe fitting both oxygen and acetylene gas is the reinforced rubber hose pipe. Green is the standard color for oxygen hose, red for acetylene, and black hose for other industrially available welding gases.

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Oxygen Cylinder:

For proper burning of fuel, appropriate amount of oxygen required. This oxygen supplied by a oxygen cylinder. A black line is used to indicate oxygen cylinder.

Fuel Gas Cylinder:

Gas cylinder is filled either by oxy acetylene gas, hydrogen gas, natural gas or other flammable gas. The fuel gas selection is depends on the welding material. Mostly oxy acetylene gas is used for all general purpose of welding. Normally these cylinders have Maroon line to indicate it. The fuel gases passes through it.

Pressure regulator:

Both oxygen and fuel gases are filled in cylinder at high pressure. These gases cannot use at this high pressure for welding work so a pressure regulator is used between flow. It supplies oxygen at pressure about 70 – 130 kPa and gas at 7 – 103kPa to the welding torch.

Goggles and Gloves:

These are use for safety purpose of welder. It protects eyes and hand from radiation and flame of fire.

Goggles are fitted with colored lenses and are used to protect the eyes from harmful heat and ultraviolet and infrared rays.

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Filler rods

Gas welding can be done with or without using filler rod. When welding with the filler rod, it should be held at approximately 900 to the welding tip. Filler rods have the same or nearly the same chemical composition as the base metal. Metallurgical properties of the weld deposit can be controlled by the optimum choice of filler rod. Most of the filler rods for gas welding also contain deoxidizers to control the oxygen content of weld pool.

Fluxes

Fluxes are used in gas welding to remove the oxide film and to maintain a clean surface. These are usually employed for gas welding of aluminium, stainless steel, cast iron, brass and silicon bronze. They are available in the market in the form of dry powder, paste, or thick solutions.

Spark-lighter

It is used for frequent igniting the welding torch.

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Working:

Gas welding process is quite simpler compare to arc welding.
In this process all the equipment are connected carefully.
The gas cylinder and oxygen cylinder connected to the welding torch through pressure regulators.
Now the regulate pressure of gas and oxygen supplied to the torch where they properly mixed.
The flame is ignited by a striker.
Take care the tip of torch is pointing downward.
Now the flame is controlled through valves situated in welding torch.
The flame is set at natural flame or carburizing flame or oxidizing flame according to the welding condition.
Now the welding torch moved along the line where joint to be created.
This will melt the interface part and join them permanently.

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In oxy fuel gas-welding processes, the combustion takes place in two stages.

Reaction 1- Initial reaction starts when acetylene and oxygen mixture burns releasing heat and showing a small white cone.

Reactions for oxy-acetylene welding

$C_2H_2 + O_2 = 2CO + H_2 + 448KJ/mol$ (18.75MJ/m3 of acetylene)

The inner white cone temperature is of order 3100^0

Reaction 2-The carbon monoxide (CO) and hydrogen produced in the first stage further combine with the atmospheric oxygen and gives rise to the outer bluish flame, with the following reaction

$4CO + 2H_2 + 3O_2 = 4CO_2 + 2H_2O + 812KJ/mol$(35.77MJ /m3)

In the second reaction higher amount of heat is produced but due to distribution over large area, the temperature (1200 to 2000^0) achieved is very small in the flame.

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Application:

It is used to join thin metal plates.
It can used to join both ferrous and non-ferrous metals.
Gas welding mostly used in fabrication of sheet metal.
It is widely used in automobile and aircraft industries

Advantages:

It is easy to operate and dose not required high skill operator.
Equipment cost is low compare to other welding processes like MIG, TIG etc.
It can be used at site.
Equipment's are more portable than other type of welding.
It can also be used as gas cutting.
Disadvantages:
It provides low surface finish. This process needs a finishing operation after welding.
Gas welding have large heat affected zone which can cause change in mechanical properties of parent material.
Higher safety issue due to naked flame of high temperature.
It is Suitable only for soft and thin sheets.
Slow metal joining rate.
No shielding area which causes more welding defects.

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Types of Flames in Oxy-Acetylene Gas Welding:

The types of Flames in Oxy-Acetylene Gas Welding are as follows.

Neutral Flame
Oxidizing Flame
Carburizing Flame

1. Neutral Flame:

O2/C2H2 = 1

The inner and Outer cone will be distinguished based on the color I.e. the inner cone is red or yellowish whereas the outer cone is a light blue color.

Red Colour Flame → Incomplete Combustion.

Light Blue Colour Flame → Complete Combustion.

Where N = 10 to 15 mm.

Temperature:T max = **3260**°C

Applications:

This flame is used for joining and cutting of all Ferrous and Non Ferrous metals except brass.

During the joining of brass workpieces, the zinc present in the weld bead will be getting evaporating and only copper is leftover in weld bead which is not giving required Mechanical properties of the weld bead.

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2. Oxidizing Flame:

O2/C2H2 = 1.15 to 1.5

Inner Cone is in between **N/3 to N/2.**

Temperature:

T max = 3380°C

Because of an excess amount of oxygen supplied from the oxygen cylinder, the amount of oxygen to be taken from the atmosphere is reducing. Therefore, the mixture is burning within a short duration from the tip of the nozzle.

Due to the high average temperature of the flame, high melting point metals can be welded easily.

Advantages of Oxidizing Flame:

The slightly lean mixtures will always give the highest efficiency of combustion hence the maximum temperature of the flame is higher.

This method can be used for the joining of brass pieces.

Disadvantages of Oxidizing Flame:

It should not be used for the joining of highly reactive metals like aluminum, magnesium, etc because the excess supply of oxygen from the oxygen cylinder may cause to leave the same amount of free oxygen in the flame which will be observed by the reactive metal and produces oxides.

During the joining of brass workpieces, the free oxygen present in the flame will be combining with the same quantity of zinc present in the weld pool and produces zinc oxide also called tenuous oxide.

This tenuous oxide is floating on the weld pool and it is not allowing the remaining zinc to evaporate.

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.3. Carburizing flame:

O2/C2H2 = 0.85 to 0.95

Inner Cone is in between **2N to 3N.**

Tmax = **3040**°C

The oxygen to acetylene ratio is 0.85 to 0.95 and the inner cone is in the range of 2N to 3N and the maximum temperature is 3040-degree centigrade.

because of the short supply of oxygen, the flame has to travel for larger distances to completely burn.

Hence, the heat lost by convection and radiation will become considerable.

Due to this, the maximum temperature is only about 3040-degree centigrade

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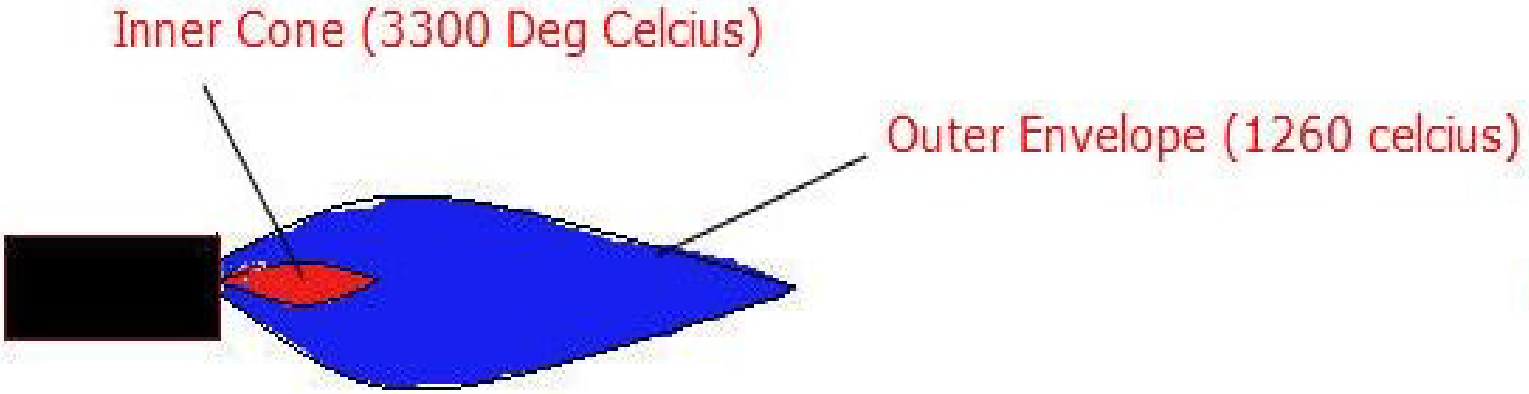
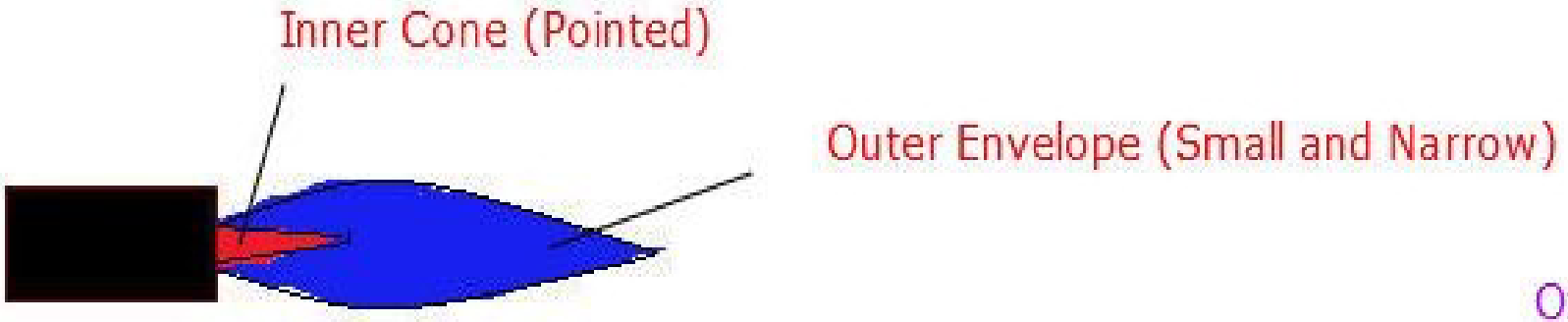
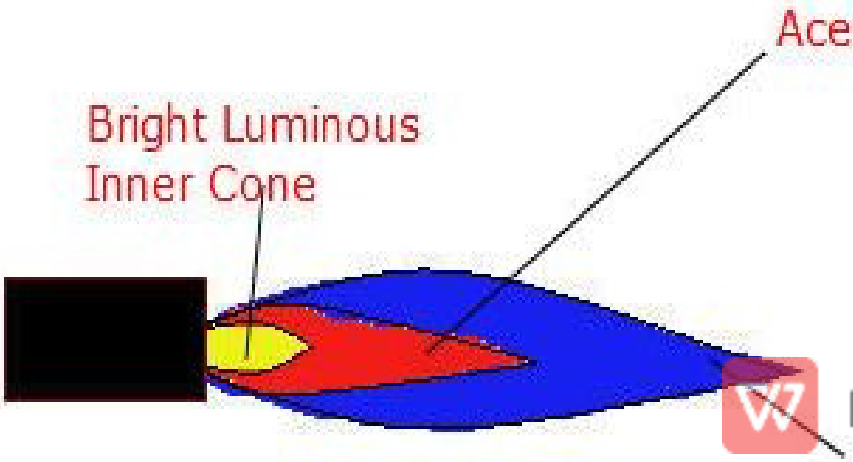


Neutral Flame



Oxidizing Flame



Carburizing or Reducing Flame

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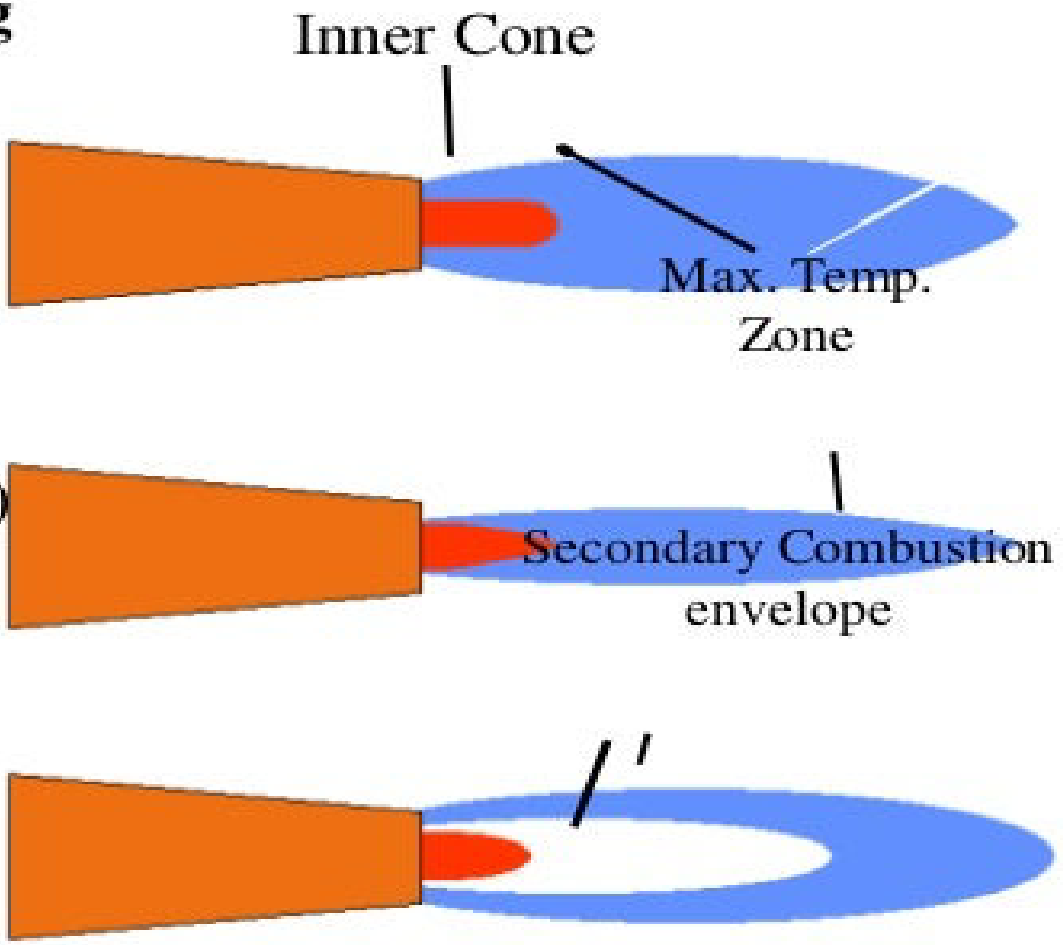
The Oxy-acetylene welding Flame

Reducing or Carburizing
Excess acetylene (0.9:1)
(Alloy steels and
aluminium alloys)

Oxidizing
Excess oxygen (1.5:1)
(Brasses, Bronzes, copper)

Neutral
Equal acetylene & oxygen
(low carbon steel, mild
steels).



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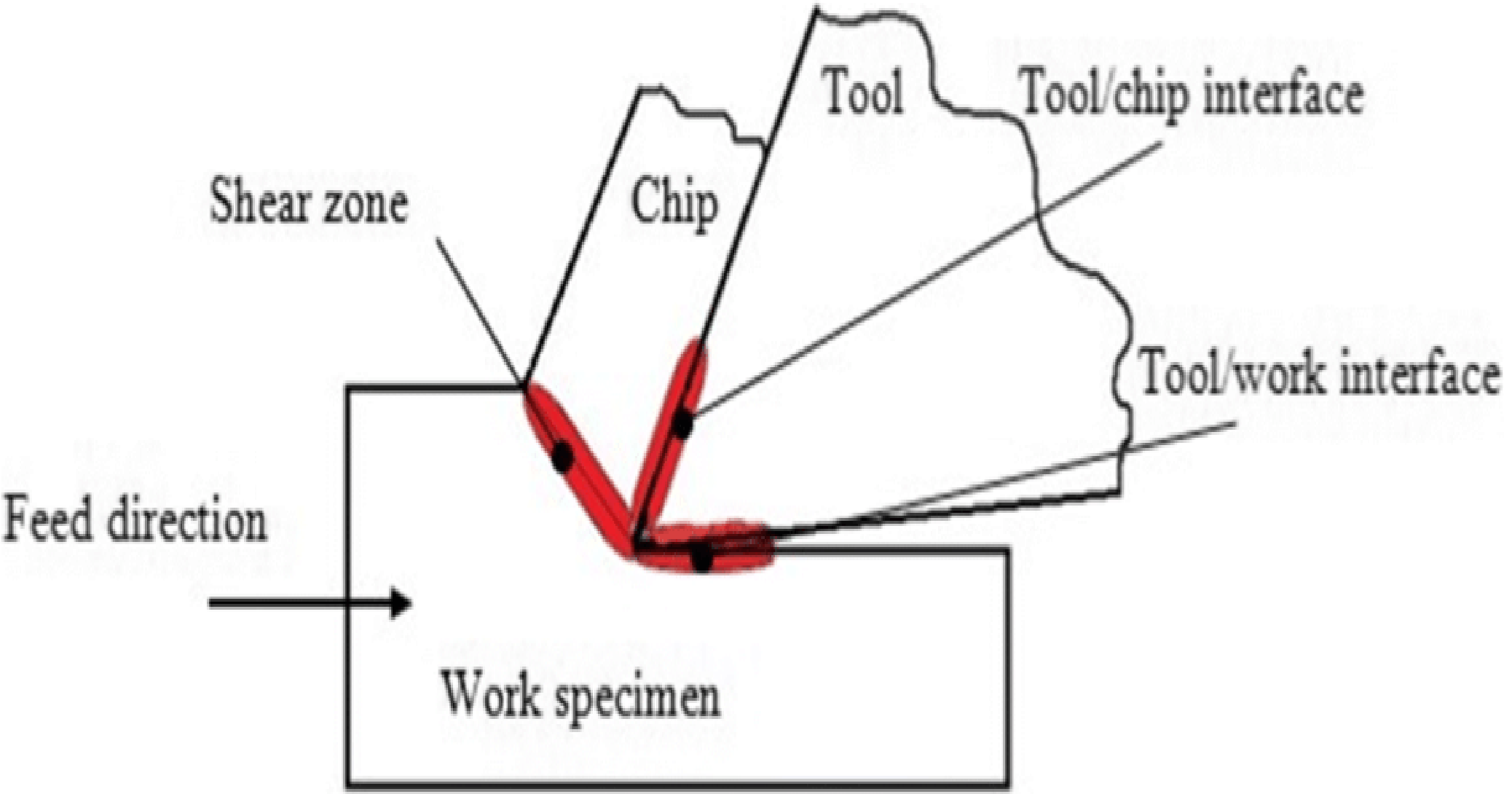

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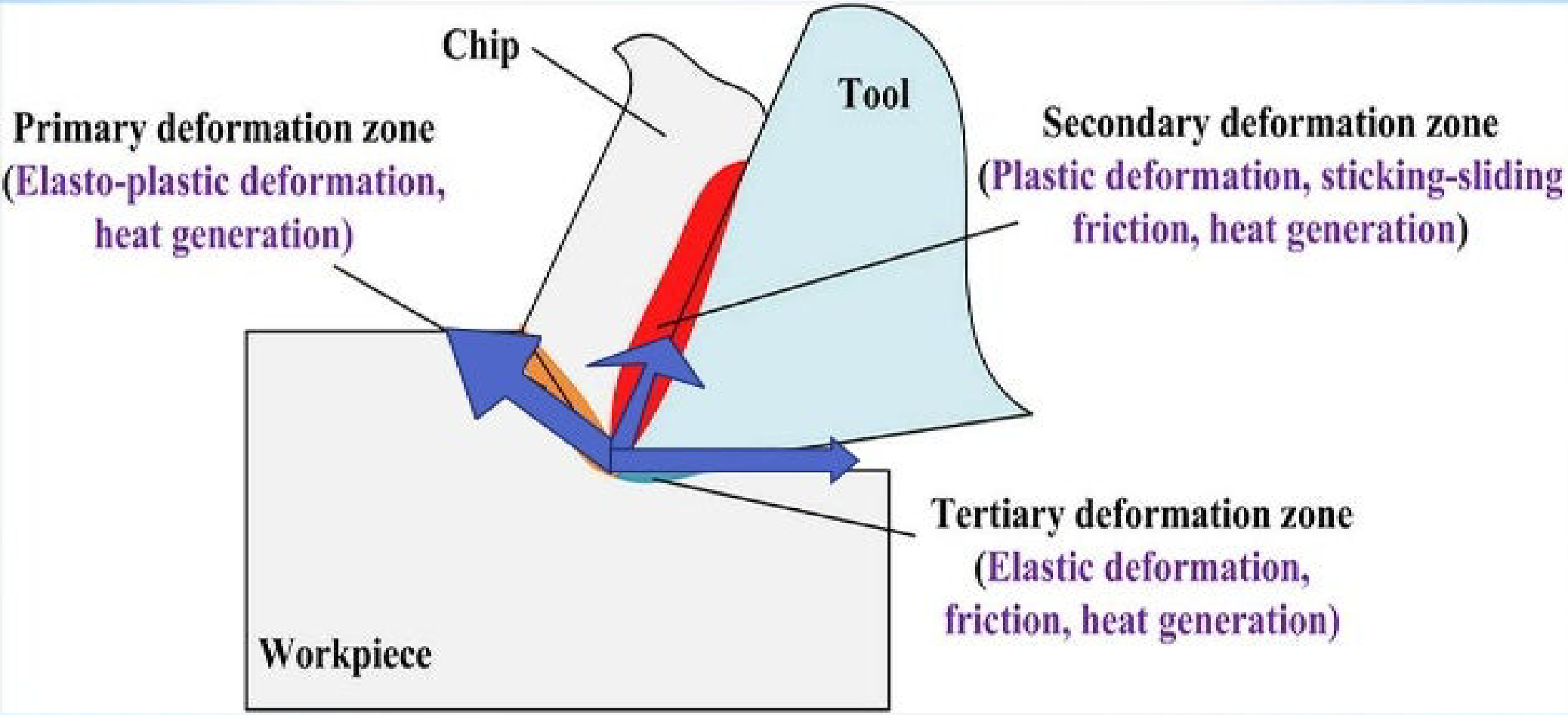
Sources of Heat in Metal Cutting



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The temperature produced in second stage is used for preheating the steels and the temperature produced in the first stage is used for melting the steel joint. Flame appearance varies with the oxygen supply.

A neutral flame is obtained with the complete combustion of acetylene and thus a complete heat in the acetylene is released.

Fig. Neutral Flame

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When less oxygen is provided, a part of combustible matter left resulting a carburizing flame. In this case a third phase of reddish intermediate flame feather is formed in between outer blue flame and inner white zone. The length of this flame feather indicates the presence of excess acetylene. The unburned carbon makes the steel excess hard and brittle. The carburizing flame is not suggested for general use. But since the flame provides a strong reducing atmosphere in the welding zone materials that readily oxidized such as high carbon steel, cast iron, cemented carbides and hard surfacing with high speed steel, the carburizing flame is useful.

Fig .Carburizing Flame

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When the oxygen is in excess,the carburizing flame is called as oxidizing flame.The flame is similar to neutral flame with the exception that the inner white cone is some what small giving rise to highest tip temperature

Fig.5.Oxidizing Flame

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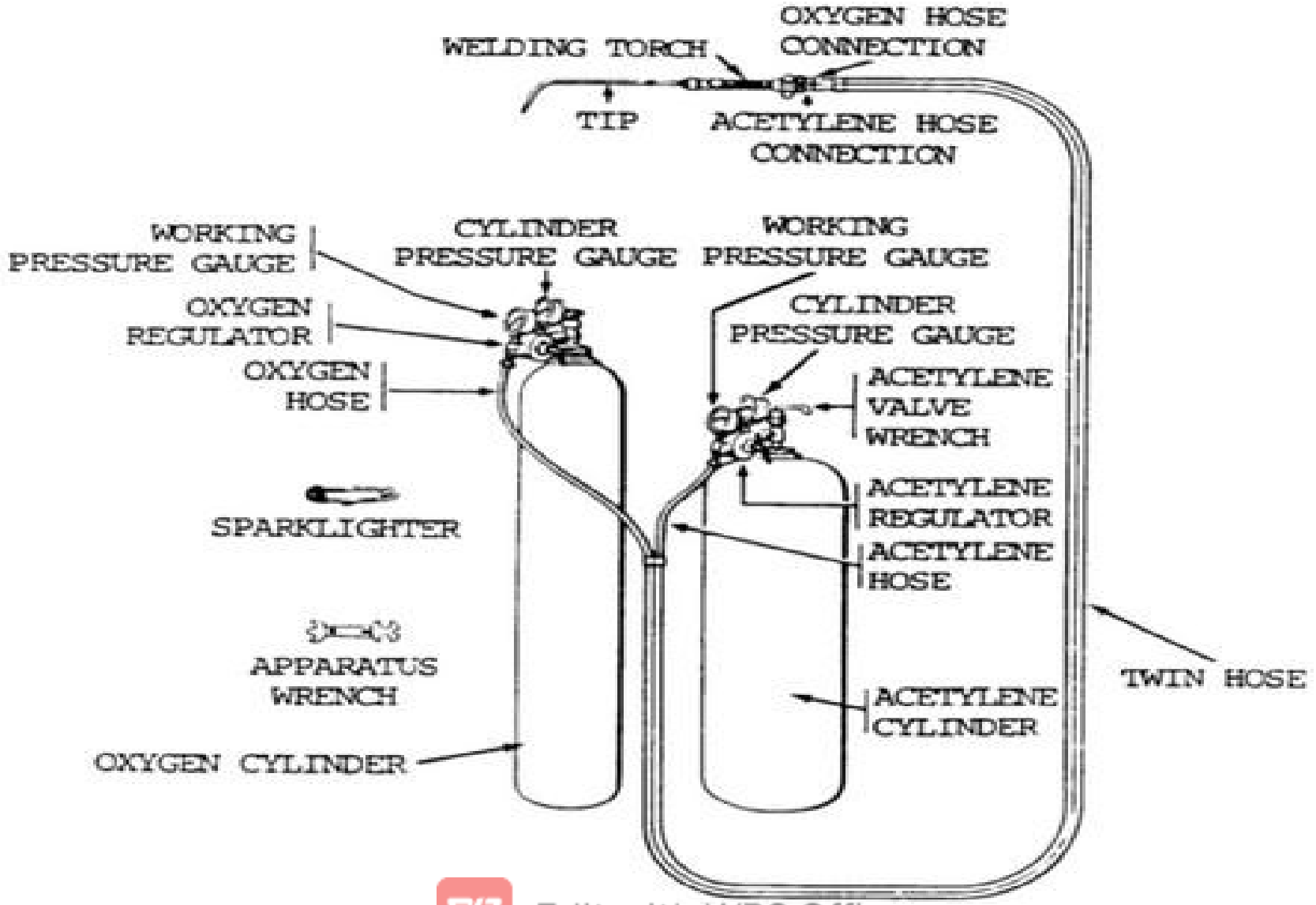
Welding equipment

Oxyacetylene carries associated regulators and torch that mixes oxygen and acetylene. The oxygen stored in cylinder at a pressure ranging from 13.8MPa to 18.2MPa.



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.Oxy acetylene welding

As acetylene is highly explosive at a pressure more than 200 kPa, hence it is stored in a cylinder filled with 80 to 85% porous material such as calcium silicate and then filled with acetone which helps in storing acetylene at a much higher pressure than permitted. The presence of acetone in flame gives a purple colour which is not desirable as it reduces the flame temperature. Therefore during release of acetylene care should be taken so that acetone should not come with acetylene. Also acetylene can be produced by acetylene generator in place of acetylene cylinder.

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The acetylene valve on the torch is opened slightly with the help of a friction spark lighter.The acetylene valve is opened to get the required flow of acetylene..The oxygen valve is slowly opened till the intermediate flame feather of the reducing flame.

- The choice of torch size depends upon the thickness of metal to be joined.
- Torch should be held at an angle of 30 to 50 degrees from the horizontal plane.
- Torch movement either oscillatory or circular.
- Torch tip should be positioned above the metal plate so that the white cone is at a distance of
1.5 to 3.0mm from the plate.
- For forehand welding the torch is moved in the direction of tip.

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Different types of gas welding flames and their applications

Neutral flame. In this gas welding flame, oxygen and acetylene are released at one-to-one ratio. That is, equal amount...

Carburizing flame. In this oxyacetylene flame, excess acetylene is supply. It inner core has a feather edge extending...

Oxidizing flame. It is obtained when oxygen is slightly more than one volume, mixed with one volume of acetylene. Just..

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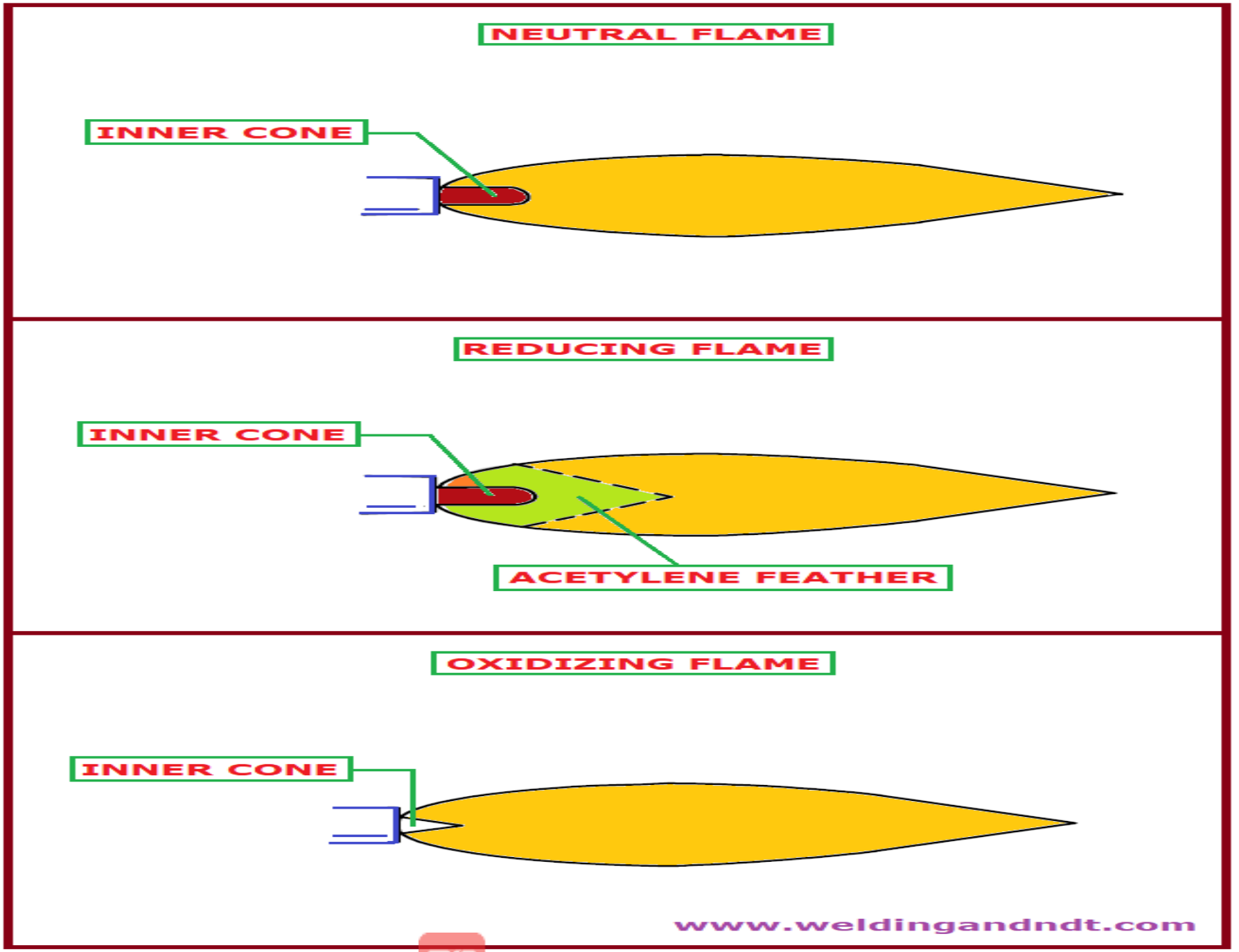
Figure - 2



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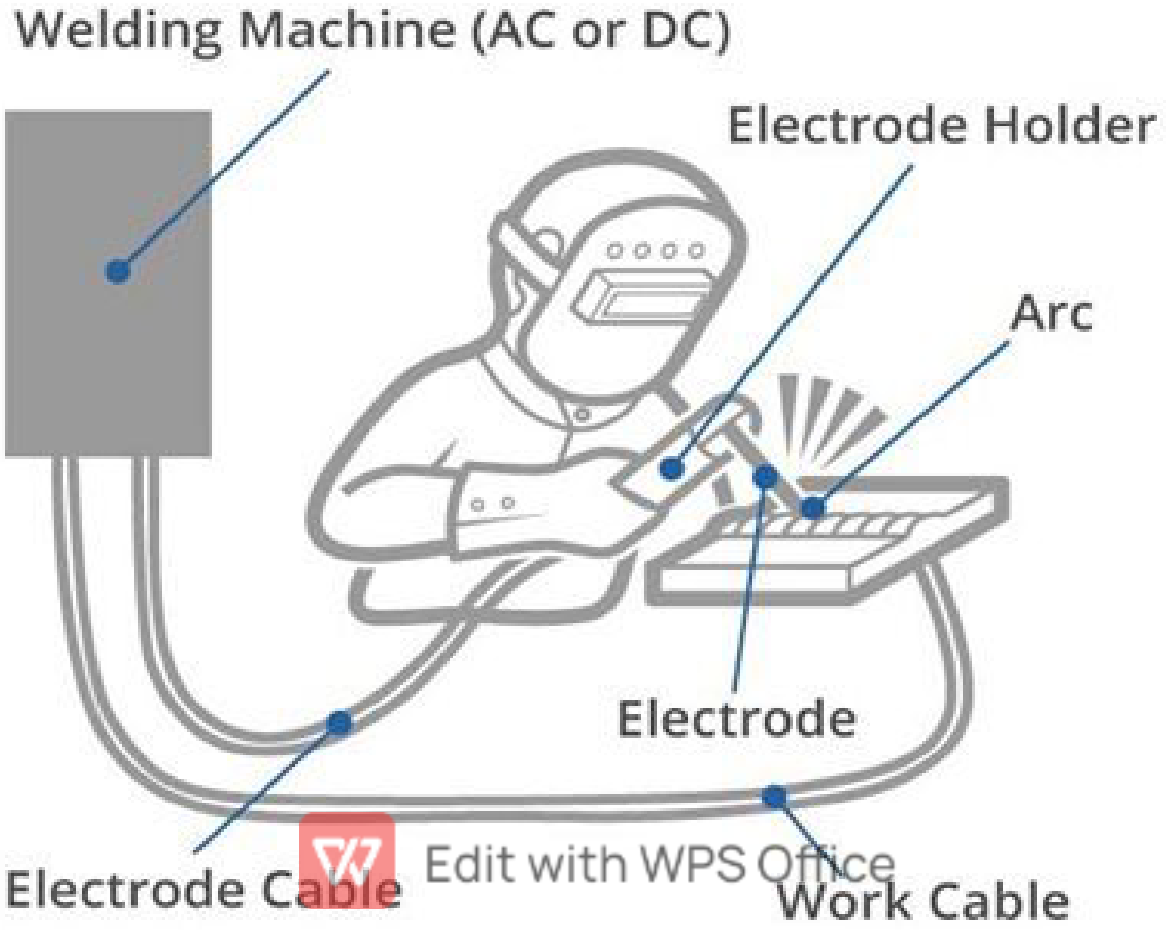
Electric arc welding Arc welding

Arc welding is a type of welding process using an electric arc to create heat to melt and join metals. A power supply creates an electric arc between a consumable or non-consumable electrode and the base material using either direct (DC) or alternating (AC) currents.

Arc welding is a fusion welding process used to join metals. An electric arc from an AC or DC power supply creates an intense heat of around 6500°F which melts the metal at the join between two work pieces.



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A problem that arises in arc welding is the contamination of the metal with elements in the atmosphere (O, H, N, etc). There can also be a problem with the surface that is not clean.

The solution to this Includes:

1.Gas shields: An inert gas is blown into the weld zone to drive away other atmospheric gases.

2.Flux: A material that is added to clean the surface may also give off a gas to drive away unwanted gases.

Arc welding working or circuit diagram:

An AC or DC power sources, fitted with whatever controls may be needed, is connected by work cable to the work piece and by an electrode cable to electrode holder of some type,
which makes electrical contact with the welding electrode.
The arc produces a temperature of about 6500-degree centigrade at the tip.
This heat melts both the base metal and the electrode producing a pool of molten metal sometimes called a creator.
The creator solidifies behind the electrode as it is moved along the joint. This result is a fusion bond.

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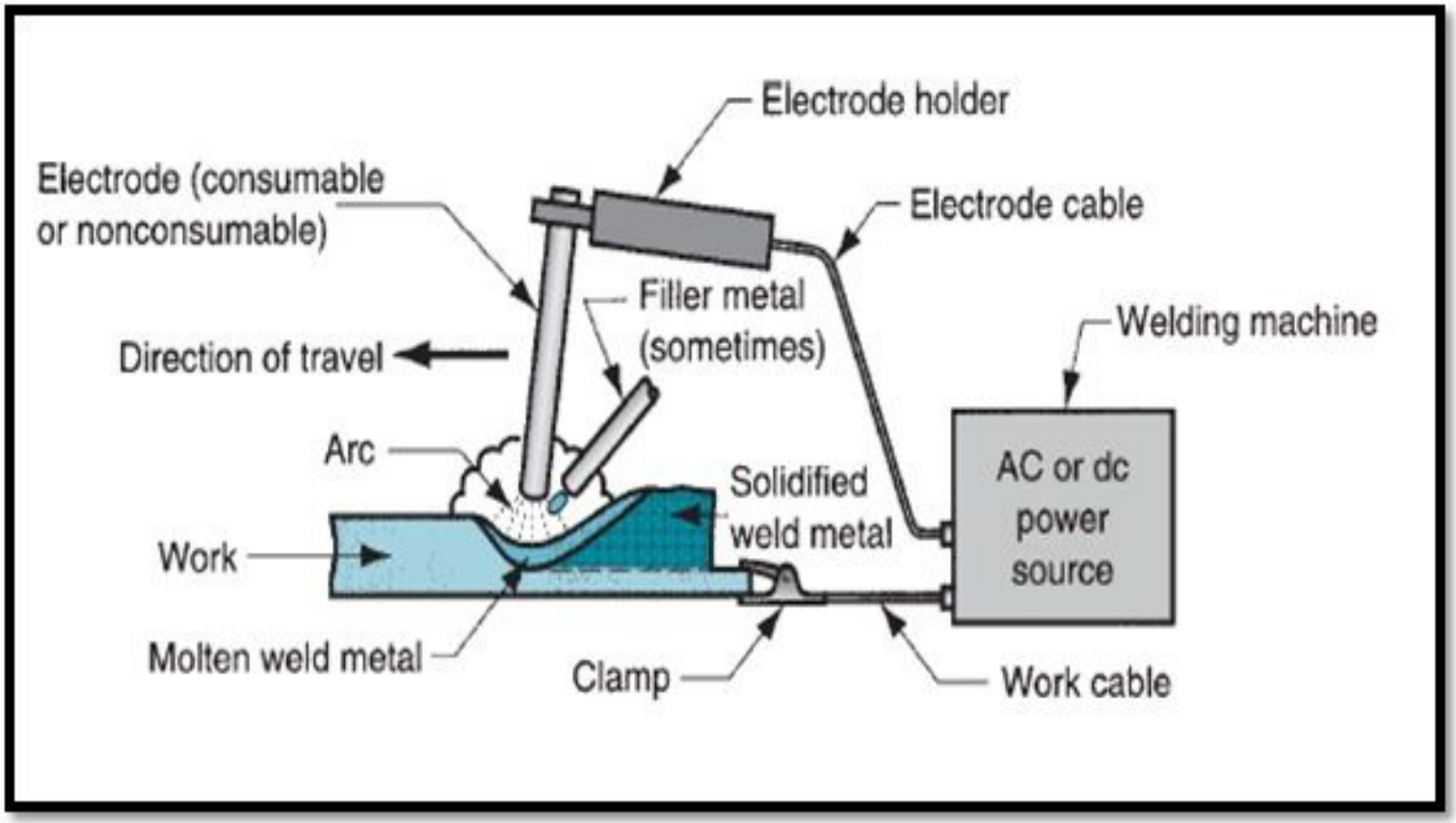

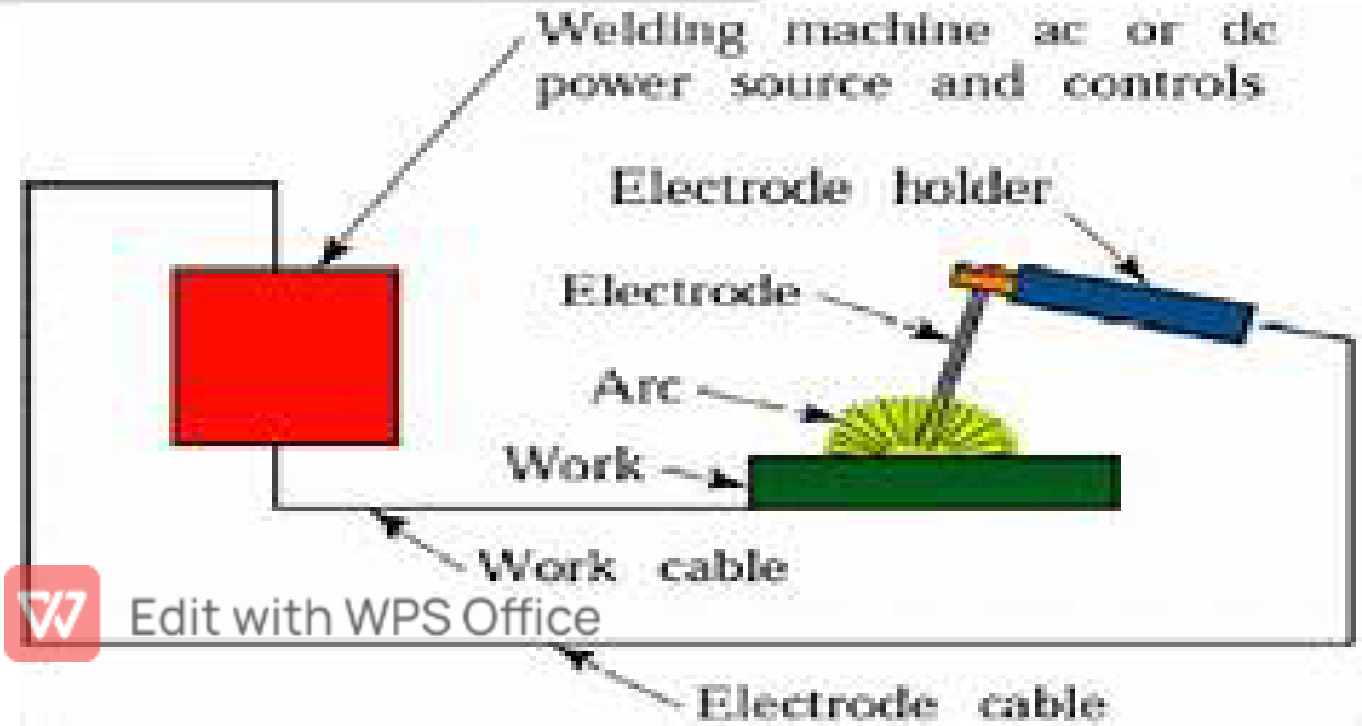

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The main parts are:

Welding Machine (Power Supply)
Cable
Holder
Electrode
Cable
Hand Gloves
Goggles
Aprons
Chipping Hammers
Wire Brush

Welding Machine (Power Supply):

Electric or Power is supplying from Direct Board to Welding Machine to Electrode cable to Electrode Holder.

Cable:

The main function is to deliver the current to the electrode holder from the machine.

Holder:

The function is to hold the Electrode.

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Electrode:

This electrode creates a spark when contacting the work.

Hand Gloves:

While performing welding operation safety comes first so for the hand we use here Hand gloves.

Goggles:

As the welding operation temperature is too high we can see the operation with the naked eye but after some time the eye gets damaged.

The eye can not sustain with high temperature therefor here we use Goggles.

Aprons:

Aprons are like clothes. We wear this for safety purposes.

Chipping Hammers:

This instrument is for holding the workpiece whenever required.

Wire Brush:

To remove unwanted material from the welded workpiece that is slag we use a wire brush.

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Arc Welding Working Principle:

The Arc welding temperature ranges from a minimum 3000-degree centigrade to up to 20000-degree centigrade. So as the Diagram is shown above in which set up has been shown.

Now supplying the power from the machine to the electrodes by the electrode cable and holder.

The work piece is mounted there than before the electrode touches the work piece we have to maintain a 2 to 3 mm gap because when you directly touch it, It might get sticks and do vibrates.

Arc Welding Advantages:

1.The process gives high deposition rates.
2.Welding speed is high.
3.Wire consumption is low.
4.The consumption of electrical energy is low, as a maximum of 97 % of heat energy can be utilized.
5.Any length can be welded without any interruption.
6.High-quality Welds are achieved with no fusion defects, no porosity and slag inclusions.

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Arc Welding Disadvantages:

1.High skilled operator required to perform an operation.
2.Arc is invisible, it can be controlled only by measuring arc voltage and current.
3.It can be used only in the down hand welding position.

Arc Welding Application:

1.The application of Arc welding in the various department like:
2.Industries Construction
3.Shipbuilding
4.Farm equipment
5.Lawn and Garden
6.Highway Equipment
7.Institutional Equipment
8.Railways Department
and There are various other places there also this arc welding is used.

Types of Arc Welding?

This process can be categorized into two different types; consumable and non-consumable electrode methods.

Consumable Electrode Methods

Metal Inert Gas Welding (MIG) and Metal Active Gas Welding (MAG)

Also known as **Gas Metal Arc Welding (GMAW)**, uses a shielding gas to protect the base metals from contamination

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Shielded Metal Arc Welding (SMAW)

Also known as **manual metal arc welding (MMA or MMAW)**, **flux shielded arc welding** or **stick welding** is a process where the arc is struck between the metal rod (electrode flux coated) and the work piece, both the rod and work piece surface melt to form a weld pool. Simultaneous melting of the flux coating on the rod will form gas, and slag, which protects the weld pool from the surrounding atmosphere. This is a versatile process ideal for joining ferrous and non-ferrous materials with a range of material thicknesses in all positions.

Flux Cored Arc Welding (FCAW)

Created as an alternative to SMAW, **FCAW** uses a continuously fed consumable flux cored electrode and a constant voltage power supply, which provides a constant arc length. This process either uses a shielding gas or just the gas created by the flux to provide protection from contamination.

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Submerged Arc Welding (SAW)

A frequently-used process with a continuously-fed consumable electrode and a blanket of fusible flux which becomes conductive when molten, providing a current path between the part and the electrode. The flux also helps prevent spatter and sparks while suppressing fumes and ultraviolet radiation.

Electro-Slag Welding (ESW)

A vertical process used to weld thick plates (above 25mm) in a single pass. ESW relies on an electric arc to start before a flux addition extinguishes the arc. The flux melts as the wire consumable is fed into the molten pool, which creates a molten slag on top of the pool. Heat for melting the wire and plate edges is generated through the molten slag's resistance to the passage of the electric current. Two water-cooled copper shoes follow the process progression and prevent any molten slag from running off.

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Non-consumable Electrode Methods

Tungsten Inert Gas Welding (TIG)

Also known as **Gas Tungsten Arc Welding (GTAW)**, uses a non-consumable tungsten electrode to create the arc and an inert shielding gas to protect the weld and molten pool against atmospheric contamination.

Plasma Arc Welding (PAW)

Similar to TIG, PAW uses an electric arc between a non-consumable electrode and an anode, which are placed within the body of the torch. The electric arc is used to ionise the gas in the torch and create the plasma, which is then pushed through a fine bore hole in the anode to reach the base plate. In this way, the plasma is separated from the shielding gas.

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